OBSERVATIONS ON THE LIFE HISTORY AND PHYSIOLOGICAL CONDITION OF THE PACIFIC DOG FISH (*SQUALUS SUCKLII*).

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Incidental to an investigation of the reactions of *Squalus sucklii* to variations in the salinity of the surrounding medium (1) observations were made regarding the life history and physiological condition of this fish.

The fish were captured during the months of June, July and August of 1926 from the Straits of Georgia in the vicinity of Departure Bay, Vancouver Island, B. C. They were taken on a set line, the hooks of which were baited with pieces of salted herring. Most of the fish were obtained at a depth of about 30 meters, and they were generally caught near kelp beds. A sample of water taken at a depth of 30 meters in the region where many of the fish were taken was found by Lucas (2) to have the following characteristics; pH 8.4, temperature 10.3° C., density 1.0218, oxygen content 4.41 cc. per liter, sodium chloride content 27.37 gm. per liter.

Weight of Fish.—It was found that many of the factors associated with the weight of the fish could be emphasized by grouping the fish according to weight as has been done in Table I. Examination of this table shows that with the fish of lighter weight the two sexes are nearly equally represented, the number of males being slightly greater. As heavier fish are considered, the relative number of males shows a marked increase, then a sudden decrease so that in the weight divisions above 4,000 grams the males are entirely absent.

These results probably indicate that male fish with body weight over 4,000 grams do not exist in this locality during the summer. It cannot be definitely stated that the figures obtained with fish of lighter weight indicate the relative proportion in which the

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TABLE I.

Weight Limits (Grams).	Number of Fish Obtained.	Number of		Percentage.		Average Length (Cm.).	Average Increase in Length.
		Males.	Females.	Males.	Females.		
300–399 . .	12	7	5	58	42	39.9	
400–499 . .	15	9	6	60	40	43.6	3.8
500–599 . .	16	11	5	69	31	45.7	2.1
600–699 . .	13	8	5	62	38	48.4	2.7
700–799 . .	5	5	0	100	0	52.5	4.1
800–899 . .	7	4	3	57	43	53.8	1.3
900–999 . .	5	5	0	100	0	54.7	0.9
1,000–1,499 .	22	20	2	91	9	60.3	5.6
1,500–1,999 .	11	9	2	82	18	69.2	8.9
2,000–2,999 .	30	26	4	87	13	74.9	5.7
3,000–3,999 .	13	5	8	38	62	83.3	8.4
4,000–4,999 .	16	0	16	0	100	90.5	6.2
5,000–5,999 .	16	0	16	0	100	91.6	1.1
6,000–6,999 .	4	0	4	0	100	95.5	3.9
7,000–7,999 .	1	0	1	0	100	99.0	3.5

two sexes occur, although such probably is the case. Since the fish were taken on a set line hunger or greed might conceivably be a factor in determining whether or not fish would take the bait. The stomach of fish captured usually contained much food, a fact which indicates that feeding for this fish is determined more by the availability of food than by hunger.

Out of 219 fish captured, 128 (58 per cent.) were males. Craigie (3) examined the fish obtained in the same region during July and August, 1925, and found that among 76 specimens 44 (60 per cent.) were males, while during December of 1925 by examining 117 specimens he found 47 (40 per cent.) males.

As was to have been expected, there is a comparatively definite relationship between weight and length of fish. The increase in length is rather steady though not entirely uniform as heavier fish are compared with those of lighter weight. It could not be shown that sex altered the relation of weight and length. There was a slight though inconstant indication that nonpregnant females were longer than pregnant females of the same weight. The longest fish captured measured 99 cm., the shortest 35.5. The heaviest fish weighed 7,550 grams and the lightest 300 grams. When increasing their weight 100 grams the smaller fish made an increase in length of approximately the same magnitude as did the larger fish when making a weight increase of 1,000 grams.

Pregnancy and Embryos.—Of the females captured, 43 per cent. carried embryos large enough to be readily noted in a cursory inspection. The lightest fish having embryos weighed 3,440 grams and was 85 cm. in length. These figures give an approximate minimum limit of the size of the mature female. Among the 50 females captured with a weight equal to or above 3,440 grams, 39 (78 per cent.) carried embryos.

Ford (4) quotes the conclusion of several investigators that *Squalus acanthias* breeds throughout the year and of other investigators that this species breeds only during certain periods. The results of his own investigations support the latter conclusion and tend to show that near Plymouth, England, specimens ready for birth would not be found earlier than the end of August. I found specimens of *Squalus sucklii* embryos at all times during the summer which ranged through all the sizes from the smallest to those with the umbilical scar healed completely and apparently ready for birth. This observation naturally suggests that in the vicinity of Nanaimo, *Squalus sucklii* breeds at all times of the year.

In any one parent, the embryos were of the same general size. A set of developing eggs was always found in females carrying embryos. The number of embryos obtained from 16 fish varied between 3 and 11 with an average number of 6.87. Although it could not be definitely stated that none of the embryos had been lost from the mother in the course of capture it is believed that this was a rare occurrence. No embryos were lost after the mother was taken from the set line and in most cases egg capsules still unruptured were obtained. In an examination of Squalus acanthias Ford (4) found that females of this species could carry as many as 11 embryos but the greatest number of pregnant fish carried only 3. In *Squalus sucklii* I found that embryos of both sexes usually occurred in the same uterus but there was no relation between the number of either sex, *e.g.* in one fish I found 6 females and 1 male, in another 3 males and no females. Of the embryos obtained 50 per cent. were males. This figure is to be contrasted with that previously noted for the fish of small size taken on the set line where a preponderence of males existed. A blue shark, *Prionace glance,* (identified by Professor J. R. Dymond) received at the Pacific Biological Station, August 19,

1926, was found to have 11 females and 8 male embryos all the same size nearly ready for birth.

Constitution of Shoals.—Throughout the period fish were being taken, the specimens obtained on any set line usually consisted of both sexes in approximately equal numbers and of all sizes. The conclusion was reached that the shoals consisted of both sexes and all sizes of fish or else the line had been visited within a few hours by several different shoals. It was also noted that the largest fish were usually taken at a greater depth (very near or actually on the sea bottom) than the smallest and it may be that the composition of shoals is in part determined by size. From his study of *Squalus acanthias*, Ford (4) concluded that for this species the mature males and females each form separate shoals while these shoals in turn are distinct from those composed of immature males and females together. I obtained fish in the same region throughout the summer. It is therefore likely that certain shoals inhabit this region during the entire season.

Summary.

1. Among the smaller fish males were slightly more prevalent than females. Males weighing more than 4,000 grams were not obtained. Females attain a much greater length and weight than males. The greater weight of the females was not always due to the presence of eggs or embryos.

2. A comparatively definite relationship exists between weight and length of fish. The relationship of length increase to weight increase for small fish is approximately ten times as great as for large specimens.

3. Of the mature females captured 78 per cent. carried embryos. This species apparently breeds throughout the year. The average number of embryos carried by the females is greater than six.

4. The shoals apparently consist of fish of all sizes and of both sexes. The shoals probably remain in the same region throughout the summer.

References.

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